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71 Applicant(s): *OUTIREN Kaddour*. - AL.

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72 Inventor(s): Kaddour Outiren.

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73 Owner(s):

74 Agent(s): Cabinet Hirsch

54 Electrical equipment with a main electrical apparatus and an auxiliary electric motor.

57 An electric motor operating at a relatively high amperage for the power provided and electrical equipment comprising such an electric motor.

[diagram]

The electric motor (MI) of the blower fan is mounted in series on the electrical circuit of the heating apparatus (E, R) in such a way as to operate at the alternating heating current (I) of this apparatus.

Application to the achievement and electrical powering of highly reliable low power motors.

ELECTRICAL EQUIPMENT WITH A MAIN ELECTRICAL APPARATUS AND
AN AUXILIARY ELECTRIC MOTOR

This invention deals with electric motors (induction: asynchronous or synchronous, single or polyphase or with a collector), generally with limited power, but operating at a relatively high amperage for the estimated rated power as well as with the electrical equipment related to this motor and comprising a main electrical apparatus and at least one auxiliary motor according to the invention, in particular for heating or air conditioning equipment.

Although the price of electric motors decreases steadily in relation to the power of these motors, this power-related decrease in price ceases when it comes to low power motors (approximately 20 watts). Such low power electric motors are much easier to achieve if they operate at low voltages (6 - 24 volts, as demonstrated by electric train motors, generally operating very economically at less than 12 VDC despite their collector and excitation by permanent magnets) rather than the domestic mains voltage (single phase 220 or 110 volts) or that of small scale networks (three phase 220 or 380 volts).

The windings of these motors must in fact be achieved with fine wire (a diameter between 10 and 20/100 mm) to limit the weight and volume of the windings, but such fine windings have significant disadvantages:

- Fine wire is fragile and often breaks during winding and in service in exposed areas, which causes the irreparable destruction of the motor;
- The insulation of fine wire with enamel results in a thickness at least equal to that of heavy wire, which reduces the proportion of copper in the winding sections accordingly, often increases the expansion coefficient of the windings and in particular resists the transfer of heat to the outside due to the poor thermal conduction of electrical insulation.

An example of a low power electric motor with fine wire windings is the serial motor with a collector or vibrator in electric razors in which a suitable compromise between power and volume is achieved only by anticipating a maximum operation time (in principle 10 minutes) so that cooling actually takes place when they are turned off.

To resolve this difficulty regarding windings and cooling in low power electric motors, in all applications where the reliability of the motor is essential, the low power motor is supplied with low voltage through a voltage step-down transformer.

This invention proposes to achieve equipment with a low power electric motor, ie. an assembly consisting of the motor and its electrical power and electrical equipment using energy and comprising a main electrical apparatus and at least one auxiliary motor, which provides the benefits of low voltage electrical power without the installation of a voltage step-down transformer, a transformer whose cost is often several times that of this same mass produced electric motor and which often entails electrical losses and significant additional weight and volume as well.

To this end, at least one circuit of at least one auxiliary motor is connected in series to at least one electrical circuit of the other higher power main electrical apparatus to make up an "intensity" motor (MI) through which the current passing through the main electrical apparatus travels and which is wound with wire with a large cross-section. The other electrical apparatus is thus part of an electrical assembly which includes the intensity electric motor(s) (MI).

Electrical equipment according to the invention, and made up of an electric heating apparatus constituting the main electrical apparatus and equipped with at least one blower fan with an electric motor, is characterized in that the electric motor of the blower fan is an induction motor mounted in series on the electrical circuit (single or polyphase) of the heating apparatus such that it operates at the alternating heating current and is wound with wire with a large enough cross-section to support the heating current without overheating.

In the same way, electrical equipment comprising at least one electric motor according to the invention and a compressor that is driven by an electric motor constituting the main electrical apparatus and combined with a thermal circuit such as that of a refrigerator, air conditioner or heat pump, in which the rotation of at least one fan or pump is driven by an electric motor, is characterized in that the electric motor of the fan or pump is an induction motor connected in series with the compressor motor, such that it operates at the alternating current passing through the compressor motor and is wound with wire with a large enough cross-section to support this current without overheating.

The intensity electric motor (MI) mounted in series on the main electrical apparatus has electrical characteristics such that when in service, it causes only a slight voltage drop (for example, about 3 - 5%) at the terminals of the main apparatus in relation to the voltage of the electrical network supplying this main apparatus, which is a standard apparatus for the voltage of the electrical network.

According to another method of achieving the equipment according to the invention, the intensity electric motor is connected to the electrical network on the side of the equipment's ground circuit and is insulated only for the voltage appearing in service between its input and output terminals while the ground circuit of its yoke and housing is connected to the ground circuit of the equipment.

According to another method of achievement, if the main electrical apparatus is likely to be connected to an electrical circuit in which the ground terminals are not defined, the ground circuit of the intensity electric motor is insulated from the ground circuit of the main electrical apparatus while the winding of the intensity electric motor (MI) is insulated at low voltage from the housing of this motor.

If the electrical equipment includes a polyphase main electrical apparatus, such as a three phase asynchronous motor and is equipped with at least one low power auxiliary electric motor, the auxiliary electric motor is a single phase motor (in particular with shaded poles), mounted in series on the circuit of only one phase of the main electrical apparatus whose other

phases are totally independent of this auxiliary motor constituting an intensity motor.

According to an advantageous feature of polyphase electrical equipment, at least the electrical resistance and if necessary the reactance of the phase of the main electrical apparatus on which the single phase intensity motor is connected in series is less than that of the other phases such that the sum of this lower resistance or reactance and the resistance or reactance of the intensity motor is approximately equal to the resistance or reactance of the other phases and the three phase circuit of the electrical assembly is approximately balanced in service.

Other objectives, advantages and characteristics of the invention will appear in the description of the various methods of achievement, which is non-restrictive and refers to the attached drawing in which:

- Figure 1 schematically represents the classic connection of a low power electric motor to a single phase domestic network;
- Figure 2 schematically represents the method of connecting the motor system according to the invention in cases where the low power motor is connected in series with a main electrical apparatus, but on the ground side of the single phase connection;
- Figure 3 represents the same method of connection as in Figure 2 in cases where the low power motor is likely to be connected in series on the phase side of the single phase connection;
- Figure 4 schematically represents a more complex method of connecting the motor system according to the invention, in cases where the main apparatus is a three phase asynchronous motor and the low power electric motor is also a three phase electric motor while a single phase intensity motor with an even lower power is inserted in series on one of the phases of the three phase apparatus.

Figure 1 shows the classic connection to the single phase domestic electrical network of a low power electric motor (M) whose input terminals (m1 and m2) are each connected to one of the terminals (a and b respectively) of an electrical outlet supplied with single phase alternating voltage (U) from the domestic network, where the most common voltage is 220 V between the phase terminal (a) and ground terminal (b) below the frequency of the interconnected network, 60 Hz in Europe and 50Hz in many other countries.

In the known method of achievement, represented in Figure 1, the rotor winding is made up of the classic, reliable and efficient squirrel cage of asynchronous motors, but the stator winding must be made of fine wire so that the motor is not too heavy. For power less than 10 W, wire diameters are about 10/100 mm and the windings thus contain almost as much insulation as metal for conducting electricity. This feature of fractionary power motors with shaded poles is even more pronounced in other types of motors, in particular universal motors with collectors used for electric razors. Shaded pole motors are able to start alone without an auxiliary phase condenser if they are powered with single phase alternating current because each of their stator poles contains a short-circuit spiral that is electrically out of phase with the main electrical pole and thus forms an auxiliary pole in service.

According to the first method of achieving the invention represented in Figure 2, electrical equipment comprising a main electrical apparatus (E), of which the electrical part is for example a resistor (R), is connected through its terminals (e1 and e2 respectively) to the "phase" terminal (a) of an outlet or electrical connection and the terminal (m1) of a low power electric motor (MI) wound according to the invention with heavy wire, causing only a slight voltage drop at its terminals. The motor (MI) contains for example a stator winding with 40/100 mm diameter copper wire achieving two poles of 150 turns each on the motor. Other winding characteristics are achieved in other applications, in particular with a heavier wire and lower number of turns for higher currents at low voltage or with a higher number of turns for lower currents or with higher voltages at the terminals. The second terminal (m2) of the motor (MI) is permanently connected to the neutral terminal (b) of the single phase electrical network which is itself connected to the ground, which has the effect of limiting the voltage of the winding of the motor (MI) to low voltage values in relation to the ground and eliminates the risk of electrocution

and allows this winding to be achieved with little insulation in relation to the ground, as the housing of the motor (MI) is of course grounded with the electrical apparatus.

When the electrical assembly is turned on, the amperage of the alternating current (I) passing through the low power motor (MI) and the resistor (R) is essentially defined by the value of the resistor (R) (which may vary considerably with the current (I), in particular if the resistor (R) is the filament of an electric light) which is much higher than the resistance and reactance ($R + L\omega$) of the fractionary electric motor (MI) (at least 20 times higher). The operation of the motor (MI) is thus determined only by the intensity of the alternating current (I) passing through it, hence the term "intensity motor" that is proposed for this type of connection and achievement of a low voltage motor with a relatively high amperage for the power provided. If there is a complete short-circuit at the terminals of the electric motor (for example at its housing), the motor (MI) ceases to function, but the current (I) scarcely increases and the main apparatus (E) is still supplied with the correct current and due to the ground connection to the motor housing, there is no risk of electrocution when the motor (MI) is touched. If there is a partial short-circuit on the winding of the motor (MI), it usually continues to operate without affecting the electrical circuit. If the winding of the motor (MI) is cut, the equipment stops functioning, but this situation is very improbable due to the fact that the winding of the motor (MI) is of heavy wire.

The method of achievement represented in Figure 3 is related to that of Figure 2 with regard to the operation of the motor (MI) and main electrical apparatus (E), as the electrical equipment may be for example connected to an outlet on which the phase side and ground side are not marked. The intensity motor (MI) may therefore be connected as represented in Figure 3 on the phase side and, in order to avoid having to insulate the heavy wire winding of the motor (MI) below the voltage of the network, in relation to the housing of this motor (MI), it is possible to mount the casing or housing of this motor (MI) on insulating studs and also to insulate its output shaft or the link of this shaft with a driven apparatus such as an impeller (which may for example as a variation be achieved using an insulating material, in particular plastic). If there is a short-circuit on the winding of the motor (MI) connected according to the method of achievement in Figure 3, the housing (C) of the motor (MI) may be connected to the phase terminal (a) of the electrical outlet with no risk of causing a general short-circuit, because this

housing (C) is insulated from the ground circuit of the electrical assembly and the main electrical apparatus (E) remains correctly powered.

The method of achievement represented in Figure 4 corresponds to the supply of three phase power to the main electrical apparatus made up for example of the electric motor (MC) of an electrical air conditioning compressor. The electric motor (MC) has 3 input terminals (c1, c2 and c3) from the three phase network (phases 1, 2, 3) and a neutral (n), and the connection here is achieved in a star with a centre point (T) connected to the ground and to the ground or housing of the motor. The electrical assembly in Figure 4 includes for example a relatively powerful blower fan motor (MV) (for example 100 W) of a refrigerating condenser and must provide good performance and good cold start qualities. This fan motor (MV) is therefore achieved with a three phase winding in which each phase (p1, p2, p3 respectively) is insulated from the neighbouring phases but mounted in series on one of the phases of the main motor (MC) of the compressor. In this way, each phase winding of the motor (MV) may be achieved in heavy wire with the same cross-section as the wire in the main motor (MC), and it is possible to ensure that the fan motor (MV) has good starting torque, significantly higher than that of a single phase motor with shaded poles, and that it starts at the same time as the main motor.

The air conditioning installation may include a refrigeration liquid circulating pump requiring only low mechanical power (for example 10 W). Such a low power motor can be achieved advantageously in the form of a single phase motor with shaded poles (MP) connected as an intensity motor to one of the phases of the main electric motor (MC). According to the method of achievement represented, the pump motor (MP) is connected between the terminal (c3) of the motor (MC) and the phase circuit (p3) of the fan motor (MV), but could also be connected to either of the other two phases of the electrical circuit and in another position of the phase circuit.

According to one advantageous feature, a slightly higher resistance could be provided on the winding of the motor (MC) ending on the terminal (c3) and/or the phase winding (p3) of the motor (MV) in such a way as to compensate at least partially for the phase imbalance caused on the phase (3) by the presence of the pump motor (MP) connected as a single phase

intensity motor. It is also possible to balance not only the phase resistances of the single phase network but also the phase reactances in order to have the best possible balance between the phases. According to the connection method represented in Figure 4, one contactor is enough to simultaneously turn on the compressor motor (MP) (which generally has a power between 1 and 5 kW for domestic air conditioners or industrial enclosures, in particular computer rooms) and the fan motors (MV) and pump motors (MP). This method of achievement according to the invention enables the achievement of motors of varying powers using a single type of insulated wire with a relatively large cross-section and good mechanical insulation and cooling characteristics while facilitating the supply of insulating wire.

The connection method as an intensity motor for low power electric motors has been represented for single phase or polyphase induction motors (including synchronous or synchronized asynchronous motors), but could also apply for direct or rectified current (wavy) networks with serial, shunt or compound direct current motors with poles or permanent magnets, including those in electrical traction.

In addition to the obvious advantages of the equipment according to the invention just described, the use of an intensity motor generally allows energy savings to be achieved due to the motor's improved performance and the elimination of the transformer which used to be necessary for low voltage motors. The intensity motor reduces the risk of short-circuits because it uses an insulated wire which is stronger due to its cross-section and insulation layer and eliminates the need for transformers to adapt the voltage and/or current. Furthermore, as demonstrated by the equipment in Figure 4, one set of contactors allows all of the motors in service on a single circuit to be turned on, i.e. the main motor and the various intensity motors (MV and MP).

This invention is of course not limited to the methods of achievement described and represented, and it is susceptible to numerous variations accessible to those skilled in the art without deviating from the spirit of the invention.

CLAIMS

1. - Electrical equipment using energy and comprising a main electrical apparatus and at least one auxiliary motor, characterized in that at least one circuit of at least one auxiliary motor is connected in series to at least one electrical circuit of the higher power main electrical apparatus (E, MC) to make up an intensity motor (MI) through which the current (I) passing through the main electrical apparatus travels and which is wound with wire with a large cross-section.

2. - Electrical equipment according to claim 1 and made up of an electric heating apparatus constituting the main electrical apparatus and equipped with at least one blower fan with an electric motor, characterized in that the electric motor (MI) of the blower fan is an induction motor mounted in series on the electrical circuit (single or polyphase) of the heating apparatus (E, R) such that it operates at the alternating heating current (I) and is wound with wire with a large enough cross-section to support the heating current without overheating.

3. - Electrical equipment comprising at least one electric motor according to claim 1 and a compressor that is driven by an electric motor constituting the main electrical apparatus and combined with a thermal circuit such as that of a refrigerator, air conditioner or heat pump, in which the rotation of at least one fan or pump is driven by an electric motor, characterized in that the electric motor of the fan (MI) or pump (MP) is an induction motor connected in series with the compressor motor (MC), such that it operates at the alternating current passing through the compressor motor (MC) and is wound with wire with a large enough cross-section to support this current without overheating.

4. - Equipment according to any of claims 1 to 3, characterized in that the intensity electric motor (MI) mounted in series on the main electrical apparatus (E, MC) has electrical characteristics such that when in service, it causes only a slight voltage drop (for example, about 3 - 5%) at the terminals of the main apparatus (E, MC) in relation to the voltage of the electrical network supplying this main apparatus, which is a standard apparatus for the voltage of the electrical network.

5. - Electrical equipment according to any of claims 1 to 4, characterized in that the intensity electric motor (MI) is connected to the electrical network on the side of the equipment's ground circuit (b) and is insulated only for the voltage appearing in service between its input and output terminals while the ground circuit of its yoke and housing (c) is connected to the ground circuit of the equipment.

6. - Electrical equipment according to any of claims 1 to 4, characterized in that if the main electrical apparatus (E, MC) is likely to be connected to an electrical circuit in which the ground terminals are not defined, the ground circuit (C) of the intensity electric motor (MI) is insulated from the ground circuit of the main electrical apparatus (E, MC) while the winding of the intensity electric motor (MI) is insulated at low voltage from the housing of this motor.

7. - Electrical equipment according to claim 1 and comprising a polyphase main electrical apparatus such as a three phase asynchronous motor and equipped with at least one lower power auxiliary electric motor, characterized in that the auxiliary electric motor is a single phase motor (MP) (in particular with shaded poles), mounted in series on the circuit (3, c3) of only one phase of the main electrical apparatus (MC) whose other phases (c1, c2) are totally independent of this auxiliary motor constituting an intensity motor (MI).

8. - Electrical equipment according to claim 7, characterized in that at least the electrical resistance and if necessary the reactance of the phase (c3) of the main electrical apparatus (MC) on which the single phase intensity motor (MI) is connected in series is less than that of the other phases (c1, c2) such that the sum of this lower resistance or reactance and the resistance or reactance of the intensity motor (MI) is approximately equal to the resistance or reactance of the other phases (c1, c2) and the three phase circuit of the electrical assembly is approximately balanced in service.